

GENE E. LIKENS

FOUNDING DIRECTOR AND PRESIDENT EMERITUS
DISTINGUISHED SENIOR SCIENTIST EMERITUS
CARY INSTITUTE OF ECOSYSTEM STUDIES

ANNUAL SCIENTIFIC REPORT
1 JULY 2014 – 30 JUNE 2015

PUBLICATIONS

Books – In Press

Holmes, R. T. and G. E. Likens. 2015. Hubbard Brook: The Story of a Forest Ecosystem. Yale University Press.

Papers – Published

Yanai, R., N. Tokuchi, J. Campbell, M. Green, E. Matsuzaki, S. Laseter, C. Brown, A. Bailey, P. Lyons, C. R. Levine, D. Buso, G. E. Likens, J. Knoepp and K. Fukushima. 2015. Sources of uncertainty in estimating stream solute export from headwater catchments. *Hydrological Processes* 29:1793-1805.

Lindenmayer, D.B., E.L. Burns, P. Tennant, C.R. Dickman, P.T. Green, D.A. Keith, D.J. Metcalfe, J. Russell-Smith, G.M. Wardle, D. Williams, K. Bossard, C. Delacey, I. Hanigan, C.M. Bull, G. Gillespie, R.J. Hobbs, C.J. Krebs, G.E. Likens, J. Porter, and M. Vardon. 2015. Contemplating the future: Acting now on long-term monitoring to answer 2050's questions. *Austral Ecology* 40:213-224.

Likens, G. E. and S. W. Bailey. 2014. The discovery of acid rain at the Hubbard Brook Experimental Forest – a story of collaboration and long-term research. *In*: D. C. Hayes, S. L. Stout, R. H. Crawford and A. P. Hoover (eds.). *USDA Forest Service Experimental Forests and Ranges. Research for the Long Term.* Pages 463-482. Springer, NY.

Smith, V. H., W. K. Dodds, K. E. Havens, D. R. Engstrom, H. W. Paerl, B. Moss and G. E. Likens. 2014. Comment: Cultural eutrophication of natural lakes in the United States is real and widespread. *Limnology and Oceanography* 59:2217-2225.

Wilson, A.M., G.E. Likens. 2015. Content Volatility of Scientific Topics in Wikipedia: A Cautionary Tale. *PLoS ONE* 10(8):e0134454. doi:10.1371/journal.pone.0134454

Likens, G. E. 2014. The Ecosystem Approach for Understanding and Resolving Environmental Problems. Pp. 103-110. *In*; *Environment and Development Challenges. The Imperative to Act.* The Blue Planet Prize Laureates. University of Tokyo Press.

Benettin, P., Bailey, S.W., Campbell, J.L., Green, M.B., Rinaldo, A., Likens, G.E., McGuire, K.J., Botter, G., 2015. Linking water age and solute dynamics in streamflow at the Hubbard Brook Experimental Forest, NH, USA, Water Resources Research, doi: 10.1002/2015WR017552.

Golladay, S.W., K.L. Martin, J.M. Vose, D.N. Wear, A.P. Covich, R.J. Hobbs, K.D. Klepzig, G.E. Likens, R.J. Naiman, and A.W. Shearer. 2016. Achievable Future Conditions as a Framework for Guiding Forest Conservation and Management. *Forest Ecology and Management* 360:80-96.

Papers – In Press and Review

Keene, W. C., J. N. Galloway, G. E. Likens, F. A. Deviney, K. N. Mikkelsen, J. L. Moody and J. R. Maben. 2015. Atmospheric wet deposition in remote regions: Benchmarks for environmental change. In Press at *Journal of the Atmospheric Sciences*.

Likens, G. E. and D. Buso. 2015. Five decades of biogeochemical change at Hubbard Brook: Implications for legacies. In Review at *Ecological Monographs*.

Campbell, J.L., R.D. Yanai, M.B. Green, G.E. Likens, C.R. See, A.S. Bailey, D.C. Buso, and D. Yang. Uncertainty in the net hydrologic flux of calcium in a paired-watershed harvesting study. In revision at *Ecosphere*.

Butler, T., F. Vermeulen, G.E. Likens, and C.M. Lehman. 2016. Temporal and seasonal trends in gaseous NH₃ and precipitation NH₄⁺ concentrations in several regions of the USA. Abstract for International Rain Conference, Rochester, NY. November 2016.

Durán, J., J.L. Morse, P.M. Groffman, J.L. Campbell, L.M. Christenson, C.T. Driscoll, T.J. Fahey, M.C. Fisk, G.E. Likens, J.M. Melillo, M.J. Mitchell, P.H. Templer, and M.A. Vadeboncoeur. 2015. Climate change decreases nitrogen pools and mineralization rates in 1 northern hardwood forests. In Press at *Ecosphere*.

Tydecks, L., V. Bremerich, I. Jentschke, G.E. Likens, and K. Tockner. *Biological Field Stations – a Global Infrastructure for Research, Education, and Public Engagement*. In Press at *BioScience*.

Puntsag, T., M.J. Mitchell, J.L. Campbell, E.S. Klein, G.E. Likens, and J.M. Welker. 2016. Arctic Vortex changes alter the sources and isotopic values of precipitation in NE US. In Revision at *Nature – Scientific Reports*.

Likens, G.E., and D.C. Buso. Five Decades of Biogeochemical Change at Hubbard Brook: Observed and Implied Legacies. Submitted to *Ecological Monographs*.

GRANTS TO CARY INSTITUTE OF ECOSYSTEM STUDIES - CONTINUING OR RECEIVED

1. Principal Investigator – “Long-term Ecological Research [LTER] at the Hubbard Brook Experimental Forest.” Subcontract from Cornell University, NSF OSP4432. 1988-2016.

2. Principal Investigator – Research in connection with CASTNET – Site 510 and NDDN Site #110, Ithaca, New York.” QST / U.S. Environmental Protection Agency. 1992-2015.
3. Principal Investigator – “Monitoring Precipitation Chemistry at Ithaca Site.” National Oceanic and Atmospheric Administration. 1992-2015.
4. Principal Investigator – “LTREB Renewal at Hubbard Brook: Hydrologic-Nutrient Cycle Interaction in Small, Undisturbed and Human-Manipulated Ecosystems.” National Science Foundation. 1993-2018.

HONORS/AWARDS

Leading Educators of the World – 2015, International Biographical Centre, Cambridge, England.

Who's Who in Science and Engineering 2016-2017 (12th Edition). Marquis Who's Who. New Providence, NJ.

BOARD MEMBERSHIPS AND ACTIVITIES

1. Honorary Trustee, Board of Trustees, Environmental Defense Fund, New York, New York; 2005-*present*.
2. Board of Trustees, Hubbard Brook Research Foundation, Hanover, New Hampshire; 1998-*present*. *Board meeting, 8 July, 3 December, 13 March; Program Committee 12 November; Committee of Scientists meeting 7 April.*
3. Board of Directors and Vice Chair, Aldo Leopold Foundation, Inc., Baraboo, Wisconsin; 1997-2007; 2008-*present*. Chair, Governance Committee, 2007-2014. Meeting 20 August, 25 October.
4. Honorary Board Member, Friends of Mirror Lake Association (FMLA), North Woodstock, New Hampshire. 2007-*present*.
5. Board of Trustees, Hudson River Foundation, New York. 2007-*present*. Board meeting 7 August, 24 September, 17 November, 5 June; Program Committee, 20 March.
6. President, Societas Internationalis Limnologiae, 2001-2007 (U.S. National Representative 2007-2016).
7. Board of Directors, Scenic Hudson, 2007-2009; President's Council of Advisors, 2009-*present*.

ADVISORY PANEL/COMMITTEE MEMBERSHIPS AND EDITORSHIPS

1. Elected U. S. National Representative to Societas Internationalis Limnologiae [organizational name change to International Society of Limnology] (SIL), 1970-2001; 2007-*present*.
2. Chairman, Scientific Advisory Committee of the Joseph W. Jones Ecological Research Center at Ichauway Plantation, Newton, Georgia, 1988-2012; Founding Member of Scientific Advisory Committee, 2012-*present*.

LECTURES/OTHER PRESENTATIONS

Courses Taught

Distinguished Research Professor, University of Connecticut-Storrs. “Nature, Science and Society Seminar Course” (Fall Semester).

Building Excellence through Planning speaker series. “A Conversation with Dr. Gene Likens,” University of Connecticut, Storrs Campus. December 1, 2015.

SCIENTIFIC MEETINGS/LECTURES

American Philosophical Society. 23-25 April 2015.

University of Connecticut, Storrs. Distinguished Ecologists and Evolutionary Biologists Lecture, 2 April; Honors Seminar Lecture, 14 October; Topics in Plant Ecology Lecture, 11 November.

Annual Hubbard Brook Cooperator’s Meeting. 9-10 July 2014.

Keynote Lecture for Connecticut American Water Works Association. 21 October 2014.

Founding Member of Scientific Advisory Committee for the Jones Ecological Research Center. Meeting, 8-13 February 2015.

ESA 100th Annual Meeting. E.S. Bernhardt, E. Rosi-Marshall, G.E. Likens, and D Buso. The forest grows but the ecosystem leaks: Calcium enrichment increases both forest biomass and nitrogen export. August 9 – August 14 2015.

ESA 100th Annual Meeting. C.T. Driscoll, C.E. Johnson, H Fakhræi, J.L. Campbell, J.J. Battles, J.D. Blum, T.J. Fahey, and G.E. Likens. Effects of changing atmospheric deposition on the structure and function of the Northern Forest: Long-term measurements, experiments and future model projections from the Hubbard Brook Experimental Forest, New Hampshire, USA. August 9 – August 14 2015.

MEMBERSHIPS IN AND SERVICE TO PROFESSIONAL SOCIETIES

American Association for the Advancement of Science (*Fellow 1965*)

American Institute of Biological Sciences (*President Elect 2001; President 2002; Past President 2003*)

American Polar Society

American Society of Limnology and Oceanography (*Vice President 1975-76; President 1976-77*)

American Water Resources Association (*Honorary Member*)

Australian Society of Limnology

The British Ecological Society (*Honorary Member, elected 1991*) Ecological Society of America (*Vice President 1978-79; President 1981-82; Honorary Fellow, 2012-present*)

Freshwater Biological Association

The Hudson River Environmental Society

INTECOL (*elected Honorary Member, 2005*)

International Water Resources Association (*Charter Member*)

International Association for Great Lakes Research

International Association for Sediment Water Science

Societas Internationalis Limnologiae (*U.S. National Representative since 1970; Executive Vice President 1998-2001; President 2001-2007*); 2007, name changed to *International Society of Limnology*, but also retaining *SIL (Societas Internationalis Limnologiae)*.

Sigma Xi

SERVICE AS REVIEWER

Proceedings of National Academy of Sciences

National Science Foundation (grant proposals and committee reports)

Numerous Faculty Promotion and Award Reviews

Public Education

- Likens and his research team (Buso, Wooster, Minicucci, P. Likens) at Hubbard Brook:
 - Contributed to the development of a comprehensive Web page for the Hubbard Brook Ecosystem Study (HBES) (www.hubbardbrook.org). Likens chairs the HBES Information Oversight Committee.
 - Led tours of the Hubbard Brook Experimental Forest and Mirror Lake for local, regional and international groups of visiting scientists, the staff of area politicians, community and environmental leaders, and members of the public.
 - Assisted and interacted with the Friends of Mirror Lake Association (Likens is an Honorary Board Member).
- Supervised the use of Likens' long-term HBES website data in reports and school exercises in response to numerous student e-mail requests.

RESEARCH ACTIVITIES

Starting with two major discoveries from research in the 1960s at the Hubbard Brook Experimental Forest (HBEF) in the White Mountains of New Hampshire (discovery of acid rain in North America, Likens *et al.* 1972) and major disruption of the nitrogen cycle caused by forest disturbance such as cutting and harvest (Likens *et al.* 1970), my long-term research has continued to address questions at the ecosystem-scale in terrestrial and aquatic ecosystems, with relevance to natural resource management. Experimental manipulation of entire watershed-ecosystems at HBEF has been a powerful tool in these studies. Continuous records of precipitation and streamwater chemistry, now spanning 53 years are the longest in the world and provide unique insights about the functioning of and change in these ecosystems. Analyses of these long-term data (www.hubbardbrook.org) have led to some 1800 scientific published papers, 9 books and 150 Ph.D. + M.S. dissertations, and over 50 Honors theses, from the

Hubbard Brook Ecosystem Study (HBES). I co-founded the Hubbard Brook Ecosystem Study in 1963.

- Acid rain in North America was first discovered at HBEF in the early 1960's. Research on acid rain and the acidification of soils and surface waters at Hubbard Brook produced data that played a major, influential role in U.S. and international assessments of the scientific, economic and political aspects of this environmental problem. This environmental problem has been addressed by policy makers, but not been solved and the research continues.
- Harvesting trees by clear-cutting has been an important management practice of the northern hardwood forest. Research at HBEF to quantify the effects of clear-cutting has been instrumental in the development of techniques to minimize the impacts of clear-cutting on forests, streams and lakes. Recommendations emanating from the HBES regarding sustainable forest harvest provided the basis for harvesting protocols in northern hardwood forest ecosystems (Likens *et al.* 1978).
- In the mid-1960's aquatic studies were initiated on Mirror Lake, located at the base of the Hubbard Brook Valley. Today Mirror Lake is one of the most intensively studied lakes in the world. The data from this research has provided critical information for the management of lake ecosystems and their watersheds. A second book about Mirror Lake was published in 2009 (Winter and Likens 2009).

My research focuses on the ecology and biogeochemistry of forest and aquatic ecosystems. These long-term studies have influenced policy decisions regarding management of natural resources and helped to guide managers and policymakers worldwide. For over 52 years, I have been working with colleagues from federal agencies, universities and NGOs on the effects of human-accelerated ecological change (Likens 1991) within the HBEF. Our goal has been to investigate how disturbance impacts diverse biological, physical, chemical and hydrological parameters of terrestrial and aquatic ecosystems within the Hubbard Brook Valley.

References Cited

- Likens, G. E. 1991. Human-accelerated environmental change. *BioScience* 41(3):130.
- Likens, G. E., F. H. Bormann and N. M. Johnson. 1972. Acid rain. *Environment* 14(2):33-40.
- Likens, G. E., F. H. Bormann, R. S. Pierce and W. A. Reiners. 1978. Recovery of a deforested ecosystem. *Science* 199(4328):492-496.
- Winter, T. C. and G. E. Likens (eds.). 2009. Mirror Lake: Interactions among Air, Land and Water. *University of California Press*. 361 pp.